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SHORT YOKE LENGTH PLANAR WRITER WITH LOW DC COIL RESISTANCE
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FIELD OF THE INVENTION

The invention relates to the general field of magnetic disks with particular reference to write heads for very narrow tracks.

BACKGROUND OF THE INVENTION

For high data rate writer application, one of the requirements is to have fast saturation and low inductance to induce short rise time. On the other hand, a low fly height for high areal density recording beyond 60 GB is needed in order to have better head performance. Many reliability problems are, however, associated with this low fly height. Problems such as thermal pole tip protrusion induced by thermal mismatch between alumina and pole materials during the writing process will create a head-disk interface problem and eventually will damage the read head. One of the solutions to reducing thermal pole tip protrusion is to reduce DC coil resistance of the writer so that less heat is generated during the writing process. Additionally, lower DC coil resistance improves the coil's thermal reliability.

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FIG. 1 is a schematic cross-section through a typical stitched writer design having two coil layers. Seen in FIG. 1 are GMR read head 10, read head lower shield 11, read head upper shield 12, write head bottom pole 13 (P1), lower coil insulation 14, seed layers 15 and 17, write gap 16, stitched top pole 19, lower coil 20, upper coil 21, upper coil insulation 22, top pole 23, coil lead 24, and alumina layer 25

The main drawback of this 2 layer coil stitched writer structure is its high DC coil resistance. This is a result of the prior art processes used for its manufacture. In particular, because of the small size and internal spacings of the coils, the preferred material for enclosing and electrically isolating the coils has been hard baked photoresist. This material is well suited to filling in tiny openings and is soft enough to accommodate volume changes in the coils due to thermal expansion while they are operating at maximum power. Present processes used for planarizing a cavity filled with a coil and hard baked photoresist require that a significant amount of the thickness of the coils be removed. This, in turn, increases the DC resistance of a given coil having a given number of turns leading to a degradation of its performance.

In this invention, we describe a novel two layer coil structure with low DC coil resistance for short yoke length stitched writer.

A routine search of the prior art was performed with the following references of

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interest being found:

In US 6,339,523 and 6,337,783 Santini describes a double coil pole tip design. In US 6,483,664 Thomas et al disclose a write head with four coil layers. US 6,466,401 (Hong et al.) teaches forming a second coil between the turns of a first coil and in US 6,204,997 Sasaki shows a plurality of thin film coil layers.

SUMMARY OF THE INVENTION

It has been an object of at least one embodiment of the present invention to provide a magnetic write head.

Another object of at least one embodiment of the present invention has been that said write head be driven by a write coil having a DC resistance less than about 3 ohms for a minimum of 7 turns.

Still another object of at least one embodiment of the present invention has been to provide a process for manufacturing said coil and write head.

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These objects have been achieved by using a modified CMP process for forming and encapsulating the write coil. After formation of the coil on the floor of a suitable cavity, the cavity and coil are overfilled with photoresist which is then hard baked. A layer of alumina is then deposited onto the surface of the excess photoresist, following which CMP is initiated. The presence of the alumina serves to stabilize the photoresist so that it does not delaminate. CMP is terminated as soon as the coils are exposed, allowing their full thickness to be retained, resulting in minimum DC resistance. Application of this process to the manufacture of a planar magnetic write head is described.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cross-sectional view of a two level planar write head of the prior art showing how the thickness of the lower coil is limited.

FIG. 2 shows the starting point for the process of the present invention.

FIG. 3 illustrates formation of the lower coil.

FIGs. 4-6 show the sub-process used for encapsulating and planarizing the lower

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coil.

FIGs. 7-8 illustrate the sub-process for forming and encapsulating the upper coil.

FIGs. 9-10 schematically show the novel process used to planarize the upper coil without delamination of the baked photoresist used to achieve encapsulation of the coil.

FIGs. 11-12 show the covering of the upper coil together with formation of a lower high permeability layer.

FIG. 13 shows the completed device including a write gap and an upper high permeability layer.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

We will now describe a process to manufacture a two coil planar magnetic read head in which the coil DCR (DC resistance) is reduced relative to similar designs described in the prior art.

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Referring now to FIG. 2, the process of the present invention begins with the provision of lower magnetic shield layer 12 (most commonly a top shield of a magnetic read head) and forming thereon disc 14a of dielectric material. Then, as illustrated in FIG. 3, lower copper coil 20 is formed on disc 14a. Coil 20 has at least 4 turns and a DC resistance that is less than about 2 ohms.

The copper coil is formed by depositing a conductive seed layer (not shown) after which the location and shape for the coil are determined by means of a photoresist pattern. This is followed by the electroplating copper onto all portions of the seed not covered by photoresist to a thickness between about 1.5 and 2.5 microns. All photoresist is then stripped away and all areas of the seed layer that are not covered by copper are removed.

Referring now to FIG. 4, layer 13a of ferromagnetic material is deposited and then patterned to form bottom section 13a of the lower pole, including centrally located lower trench 42 (depth between about 2 and 4 microns). Layer 13a is typically Co, CoNiFe, or NiFe and it is usually deposited to a thickness between about 3 and 4 microns. Trench 42 is then overfilled with layer 44 of insulating material (FIG. 5) and then planarized down to the level of trench 42 (FIG. 6).

Next, as shown in FIG. 7, insulating lid 14b, that fully covers lower coil 20 as well as trench 42 is formed, following which upper copper coil 21 is formed on it. Coil 21 has

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at least 3 turns and a DC resistance that is less than about 1.5 ohms.

Referring next to FIG. 8, second layer of ferromagnetic material 13b is deposited and patterned to complete formation of the lower pole, including an inner trench similar to trench 42 (see FIG. 4) on whose floor rest lid 14a and upper copper coil 21. Layer of baked photoresist 22 is now deposited to a thickness sufficient to cover upper coil 21 and to extend at least 1 micron above the top surface of lower pole 13 a/b.

Now follows a key feature of the invention. As illustrated in FIG. 9, layer 22 of baked photoresist and all exposed portions of the lower pole are covering with alumina layer 52 (to a thickness between about 4 and 5.5 microns), following which the structure is planarized by CMP leading to the removal of layer 52 as well as the excess baked photoresist 22 so that upper copper coil 21 and the lower pole are just exposed. This is seen in FIG. 10.

As seen in FIG. 11, second insulating lid 14c is now formed so that it fully covers upper coil 21 as well as the trench in which it sits. This is followed by the deposition and patterning of high permeability layer 16 onto lower pole 13a/b, as shown in FIG. 12. Preferred materials for high permeability layer 16 include CoFeN and it is deposited to a thickness between about 0.15 and 0.4 microns.

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Referring next to FIG. 13, formation of the structure is concluded by the formation of the non-magnetic write gap layer 36 (which is present on the lower pole only the side nearest the air bearing surface which is to the left in FIG. 13). This is followed by the formation of second layer of high permeability material 46 that contacts write gap 36 as well as the bottom pole. Layer 46 is CoFeN or CoFe and it is deposited to a thickness between about 0.15 and 4 microns. Finally, top pole 23 is formed on layer 23 of high permeability material and the process is complete.

What is claimed is: